CLAIMS

1. A spinal rod system for bridging one or more adjacent vertebrae, said system comprising

a first fastener fixed to a first vertebra;

a second fastener fixed to a second vertebra;

a rod extending at least between said first and second fasteners;

a rod retention assembly associated with each fastener for retaining said rod relative to each respective fastener;

each said rod retention assembly comprising a cup having an open top end and an open bottom end;

said bottom end of said cup having a generally circular hole forming a bottom opening, said bottom opening being sized large enough to allow a portion of said respective fastener to pass through while retaining another portion of said fastener in said cup;

said top end of said cup having a top opening and a generally cylindrical wall defining said top opening, said wall having at least two slots diametrically opposed to each other and extending downwardly from the uppermost portion of said wall;

said generally cylindrical wall having an interior cylindrical wall surface that tapers generally outwardly in a downward direction from said uppermost portion;

a cap associated with each cup being generally cylindrically shaped and having a pair of diametrically opposed tapered outer surfaces that taper radially outwardly, and having a pair of wing portions extending radially outwardly, said pair of wings further comprising vertically extending end surfaces;

whereby with respect to each cup, said rod is received in each of said slots and said cap is positioned in said cup above said rod in a manner in which said tapered surfaces contact said interior wall surfaces and said vertically extending surfaces contact the outer surface of said generally cylindrical walls.

2. A system according to claim 1, further comprising

a screw associated with each cap and adapted to be inserted through a screw hole in said cap and further adapted to be tightened to apply pressure to said rod in order to lock said rod relative to said cup.

3. A system according to claim 2, wherein

each said fastener is adapted to be locked with respect to its associated cup by progressive tightening of said respective screw.

4. A system according to claim 1, wherein

each said fastener is a screw having a head of a diameter greater than the diameter of said bottom opening, and having a threaded shaft of a diameter less than the diameter of said bottom opening.

5. A system according to claim 4, wherein

the lower portion of said screw head is generally hemispherically shaped.

6. A system according to claim 1, further comprising

a generally, inwardly tapered conical surface formed on the interior of said cup and surrounding said bottom opening.

7. A system according to claim 5, further comprising

a generally, inwardly tapered conical surface formed on the interior of said cup and surrounding said bottom opening, wherein said lower portion of said screw head rests on said conical surface in a manner in which said threaded shaft may be adjusted in angular orientation relative to said cup.

8. A system according to claim 7, further comprising

a seat spacer adapted to rest on top of each said fastener head and to be positioned beneath said rod, thereby supporting said rod relative to said fastener.

9. A system according to claim 8, wherein

the top surface of each said fastener head is generally dome-shaped and each said seat spacer has a complementary contact surface that contacts said top surface of said respective fastener head in a manner permitting angular adjustment of said respective fastener relative to said seat spacer.

10. A system according to claim 1, further comprising

a sleeve ring associated with each cup adapted to be positioned in said cup adjacent to said bottom opening and further adapted to support said associated fastener in said cup.

11. A spinal rod system for bridging one or more adjacent vertebrae, said system comprising

a first fastener fixed to a first vertebra;

a second fastener fixed to a second vertebra;

a rod extending at least between said first and second fasteners;

a rod retention assembly associated with each fastener for retaining said rod relative to each respective fastener;

each said rod retention assembly comprising a cup having an open top end and an open bottom end;

said bottom end of said cup having a generally circular hole forming a bottom opening, said bottom opening being sized large enough to allow said respective fastener to pass through;

a sleeve ring associated with each cup adapted to be positioned in said cup adjacent to said bottom opening and further adapted to support said associated fastener in said cup, whereby the inner diameter of said ring is large enough to allow a portion of said fastener to pass therethrough while retaining another portion of said fastener in said cup;

said top end of said cup having a top opening and a generally cylindrical wall defining said top opening, said wall having at least two slots diametrically opposed to each other and extending downwardly from the uppermost portion of said wall;

said generally cylindrical wall having an interior cylindrical wall surface that tapers generally outwardly in a downward direction from said uppermost portion;

a cap associated with each cup being generally cylindrically shaped and having a pair of diametrically opposed tapered outer surfaces that taper radially outwardly, and having a pair of wing portions extending radially outwardly, said pair of wings further comprising vertically extending end surfaces;

whereby with respect to each cup, said rod is received in each of said slots and said cap is positioned in said cup above said rod in a manner in which said tapered surfaces contact said interior wall surfaces and said vertically extending surfaces contact the outer surface of said generally cylindrical walls.

12. A system according to claim 11, further comprising

a screw associated with each cap and adapted to be inserted through a screw hole in said cap and further adapted to be tightened to apply pressure to said rod in order to lock said rod relative to said cup.

13. A system according to claim 12, wherein

each said fastener is adapted to be locked with respect to its associated cup by progressive tightening of said respective screw.

14. A system according to claim 11, wherein

each said fastener is a screw having a head of a diameter greater than the inner diameter of said sleeve ring, and having a threaded shaft of a diameter less than the inner diameter of said sleeve ring.

15. A system according to claim 14, wherein

the lower portion of said screw head is generally hemispherically shaped.

16. A system according to claim 11, further comprising

a generally, inwardly tapered conical surface formed on the interior of said cup and surrounding said bottom opening.

17. A system according to claim 15, further comprising

a generally, inwardly tapered conical surface formed on the interior of said cup and surrounding said bottom opening, wherein said sleeve ring rests on said conical surface and said lower portion of said screw head rests on said sleeve ring in a manner in which said threaded shaft may be adjusted in angular orientation relative to said cup.

18. A system according to claim 17, further comprising

a seat spacer adapted to rest on top of each said fastener head and to be positioned beneath said rod, thereby supporting said rod relative to said fastener.

19. A system according to claim 18, wherein

the top surface of each said fastener head is generally dome-shaped and each said seat spacer has a complementary contact surface that contacts said top surface of said respective fastener head in a manner permitting angular adjustment of said respective fastener relative to said seat spacer.

20. A spinal rod system for bridging one or more adjacent vertebrae, said system comprising

a first fastener fixed to a first vertebra;

a second fastener fixed to a second vertebra;

a rod extending at least between said first and second fasteners;

a rod retention assembly associated with each fastener for retaining said rod relative to each respective fastener;

each said rod retention assembly comprising a cup having an open top end and being fixed to said respective fastener at a bottom end;

said top end of said cup having a top opening and a generally cylindrical wall defining said top opening, said wall having at least two slots diametrically opposed to each other and extending downwardly from the uppermost portion of said wall;

said generally cylindrical wall having an interior cylindrical wall surface that tapers generally outwardly in a downward direction from said uppermost portion;

a cap associated with each cup being generally cylindrically shaped and having a pair of diametrically opposed tapered outer surfaces that taper radially outwardly, and having a pair of wing portions extending radially outwardly, said pair of wings further comprising vertically extending end surfaces;

whereby with respect to each cup, said rod is received in each of said slots and said cap is positioned in said cup above said rod in a manner in which said tapered surfaces contact said interior wall surfaces and said vertically extending surfaces contact the outer surface of said generally cylindrical walls.

21. A system according to claim 20, further comprising

a screw associated with each cap and adapted to be inserted through a screw hole in said cap and further adapted to be tightened to apply pressure to said rod in order to lock said rod relative to said cup.

22. A system according to claim 21, wherein

each said fastener is adapted to be locked with respect to its associated cup by progressive tightening of said respective screw.

23. A method of installing a spinal rod system for bridging one or more adjacent vertebrae, said method comprising

inserting a first fastener into a first rod retention cup;

inserting a second fastener into a second rod retention cup;

installing said first fastener into a first vertebra;

installing said second fastener into a second vertebra;

positioning a rod into each of said first and second retention cups so that said rod extends at least between said first and second fasteners;

wherein each said rod retention cup has an open top end and an open bottom end, and said bottom end of said cup having a generally circular hole forming a bottom opening, said bottom opening being sized large enough to allow a portion of said respective fastener to pass through while retaining another portion of said fastener in said cup, and said top end of said cup having a top opening and a generally cylindrical wall defining said top opening, said wall having at least two slots diametrically opposed to each other and extending downwardly from the uppermost portion of said wall, said generally cylindrical wall having an interior cylindrical wall surface that tapers generally outwardly in a downward direction from said uppermost portion; and

installing a cap into each cup above said rod, each said cap being generally cylindrically shaped and having a pair of diametrically opposed tapered outer surfaces that taper radially outwardly, and having a pair of wing portions extending radially outwardly, said pair of wings further comprising vertically extending end surfaces, and said tapered surfaces contact said interior wall surfaces and said vertically extending surfaces contact the outer surface of said generally cylindrical walls.

24. A method according to claim 23, further comprising

advancing a screw positioned in each cap through a screw hole in said cap in a manner in which said screw is tightened against said rod to apply pressure to said rod in order to lock said rod relative to said cup.

25. A method of installing a spinal rod system for bridging one or more adjacent vertebrae, said method comprising

inserting a first sleeve ring into a first rod retention cup;

inserting a second sleeve ring into a second rod retention cup

inserting a first fastener into said first rod retention cup such that a portion of said first fastener rests on said first sleeve ring within said first cup and another portion of said first fastener extends through said first sleeve ring and out of said first cup;

inserting a second fastener into a second rod retention cup such that a portion of said second fastener rests on said second sleeve ring within said second cup and another portion of said second fastener extends through said second ring and out of said second cup;

installing said first fastener into a first vertebra;

installing said second fastener into a second vertebra;

positioning a rod into each of said first and second retention cups so that said rod extends at least between said first and second fasteners;

wherein each said rod retention cup has an open top end and an open bottom end, and said bottom end of said cup having a generally circular hole forming a bottom opening, said bottom opening being sized large enough to allow a portion of said respective fastener to pass through while retaining another portion of said fastener in said cup, and said top end of said cup having a top opening and a generally cylindrical wall defining said top opening, said wall having at least two slots diametrically opposed to each other and extending downwardly from the uppermost portion of said wall, said generally cylindrical wall having an interior cylindrical wall surface that tapers generally outwardly in a downward direction from said uppermost portion; and

installing a cap into each cup above said rod, each said cap being generally cylindrically shaped and having a pair of diametrically opposed tapered outer surfaces that taper radially outwardly, and having a pair of wing portions extending radially outwardly, said pair of wings further comprising vertically extending end surfaces, and said tapered surfaces contact said interior wall surfaces and said vertically extending surfaces contact the outer surface of said generally cylindrical walls.

26. A method according to claim 25, further comprising

advancing a screw positioned in each cap through a screw hole in said cap in a manner in which said screw is tightened against said rod to apply pressure to said rod in order to lock said rod relative to said cup.

27. A spinal rod system for bridging one or more adjacent vertebrae, said system comprising

a first fastener fixed to a first vertebra;

a second fastener fixed to a second vertebra;

a rod extending at least between said first and second fasteners;

a rod retention assembly associated with each fastener for retaining said rod relative to each respective fastener;

each said rod retention assembly comprising a cup having an open top end and an open bottom end;

said bottom end of said cup having a generally circular hole forming a bottom opening, said bottom opening being sized large enough to allow a portion of said respective fastener to pass through while retaining another portion of said fastener in said cup;

said top end of said cup having a top opening and a generally cylindrical wall defining said top opening, said wall having at least two slots diametrically opposed to each other and extending downwardly from the uppermost portion of said wall;

said generally cylindrical wall having an interior cylindrical wall surface with at least two inverted shoulders, each inverted shoulder having a contact surface that is inclined in a direction radially outwardly from a center axis of said cup;

a cap associated with each cup being generally cylindrically shaped and having at least two shoulders extending radially outward and each having a shoulder with a contact surface that is inclined in a direction radially outwardly from a center of said cap;

whereby with respect to each cup, said rod is received in each of said slots and said cap is positioned in said cup above said rod in a manner in which said respective contact surfaces of said cup and said cap contact each other.

28. A system according to claim 27, further comprising

a screw associated with each cap and adapted to be inserted through a screw hole in said cap and further adapted to be tightened to apply pressure to said rod in order to lock said rod relative to said cup and to draw said respective contact surfaces against each other in a manner in which said generally cylindrical wall is biased radially inwardly.

29. A system according to claim 28, wherein

each said fastener is adapted to be locked with respect to its associated cup by progressive tightening of said respective screw.

30. A system according to claim 27, further comprising

a sleeve ring associated with each cup adapted to be positioned in said cup adjacent to said bottom opening and further adapted to support said associated fastener in said cup.

31. A system according to claim 30, further comprising

a generally, inwardly tapered conical surface formed on the interior of said cup and surrounding said bottom opening, wherein said sleeve ring is positioned against said conical surface between said cup and said fastener in a manner in which said fastener is supported entirely by said sleeve ring.

a generally, inwardly tapered conical surface formed on the interior of said cup and surrounding said bottom opening, wherein said lower portion of said screw head rests on said conical surface in a manner in which said threaded shaft may be adjusted in angular orientation relative to said cup.

32. A system according to claim 27, further comprising

a fastener head associated with each fastener; and

a seat spacer adapted to rest on top of each said fastener head and to be positioned beneath said rod, thereby supporting said rod relative to said fastener.

33. A system according to claim 32, wherein

the top surface of each said fastener head is generally dome-shaped and each said seat spacer has a complementary contact surface that contacts said top surface of said respective fastener head in a manner permitting angular adjustment of said respective fastener relative to said seat spacer.

34. A system for bridging one or more adjacent vertebrae, said system comprising

a first fastener fixed to a first vertebra;

a second fastener fixed to a second vertebra;

a rod extending at least between said first and second fasteners;

a rod retention assembly associated with each fastener for retaining said rod relative to each respective fastener;

each said rod retention assembly comprising a cup having an open top end and an open bottom end;

said bottom end of said cup having a generally circular hole forming a bottom opening, said bottom opening being sized large enough to allow said respective fastener to pass through;

a sleeve ring associated with each cup adapted to be positioned in said cup adjacent to said bottom opening and further adapted to support said associated fastener in said cup, whereby the inner diameter of said ring is large enough to allow a portion of said fastener to pass therethrough while retaining another portion of said fastener in said cup;

said top end of said cup having a top opening and a generally cylindrical wall defining said top opening, said wall having at least two slots diametrically opposed to each other and extending downwardly from the uppermost portion of said wall;

said generally cylindrical wall having an interior cylindrical wall surface with at least two inverted shoulders, each inverted shoulder having a contact surface that is inclined in a direction radially outwardly from a center axis of said cup;

a cap associated with each cup being generally cylindrically shaped and having at least two shoulders extending radially outward and each having a shoulder with a contact surface that is inclined in a direction radially outwardly from a center of said cap;

whereby with respect to each cup, said rod is received in each of said slots and said cap is positioned in said cup above said rod in a manner in which said respective contact surfaces of said cup and said cap contact each other.

35. A system according to claim 34, further comprising

a screw associated with each cap and adapted to be inserted through a screw hole in said cap and further adapted to be tightened to apply pressure to said rod in order to lock said rod relative to said cup.

36. A system according to claim 35, wherein

each said fastener is adapted to be locked with respect to its associated cup by progressive tightening of said respective screw.

37. A system according to claim 34, wherein

each said fastener is a screw having a head of a diameter greater than the inner diameter of said sleeve ring, and having a threaded shaft of a diameter less than the inner diameter of said sleeve ring.

38. A system according to claim 37, wherein

the lower portion of said screw head is generally hemispherically shaped.

39. A system according to claim 34, further comprising

a generally, inwardly tapered conical surface formed on the interior of said cup and surrounding said bottom opening.

40. A system according to claim 38, further comprising

a generally, inwardly tapered conical surface formed on the interior of said cup and surrounding said bottom opening, wherein said sleeve ring rests on said conical surface and said lower portion of said screw head rests on said sleeve ring in a manner in which said threaded shaft may be adjusted in angular orientation relative to said cup.

41. A system according to claim 40, further comprising

a seat spacer adapted to rest on top of each said fastener head and to be positioned beneath said rod, thereby supporting said rod relative to said fastener.

42. A system according to claim 41, wherein

the top surface of each said fastener head is generally dome-shaped and each said seat spacer has a complementary contact surface that contacts said top surface of said respective fastener head in a manner permitting angular adjustment of said respective fastener relative to said seat spacer.

43. A method of installing a spinal rod system for bridging one or more adjacent vertebrae, said method comprising

inserting a first fastener into a first rod retention cup;

inserting a second fastener into a second rod retention cup;

installing said first fastener into a first vertebra;

installing said second fastener into a second vertebra;

positioning a rod into each of said first and second retention cups so that said rod extends at least between said first and second fasteners;

wherein each said rod retention cup has an open top end and an open bottom end, and said bottom end of said cup having a generally circular hole forming a bottom opening, said bottom opening being sized large enough to allow a portion of said respective fastener to pass through while retaining another portion of said fastener in said cup, and said top end of said cup having a top opening and a generally cylindrical wall defining said top opening, said wall having at least two slots diametrically opposed to each other and extending downwardly from the uppermost portion of said wall, said generally cylindrical wall having an interior cylindrical wall surface with at least two inverted shoulders that each taper generally outwardly in an upward direction; and

installing a cap into each cup above said rod, each said cap being generally cylindrically shaped and having a pair of shoulders extending radially outwardly and in an upward direction, and said shoulders contact said inverted shoulders.

44. A method according to claim 43, further comprising

advancing a screw positioned in each cap through a screw hole in said cap in a manner in which said screw is tightened against said rod to apply pressure to said rod in order to lock said rod relative to said cup.

45. A method according to claim 43, further comprising

advancing a screw positioned in each cap through a screw hole in said cap in a manner in which said screw is tightened against said rod to apply pressure to said rod in order to lock said rod relative to said cup, and in order to draw said shoulders and said inverted shoulders into each other in a manner causing said generally cylindrical wall to be biased inwardly.

46. A method of installing a spinal rod system for bridging one or more adjacent vertebrae, said method comprising

inserting a first sleeve ring into a first rod retention cup;

inserting a second sleeve ring into a second rod retention cup

inserting a first fastener into said first rod retention cup such that a portion of said first fastener rests on said first sleeve ring within said first cup and another portion of said first fastener extends through said first sleeve ring and out of said first cup;

inserting a second fastener into a second rod retention cup such that a portion of said second fastener rests on said second sleeve ring within said second cup and another portion of said second fastener extends through said second ring and out of said second cup;

installing said first fastener into a first vertebra;

installing said second fastener into a second vertebra;

positioning a rod into each of said first and second retention cups so that said rod extends at least between said first and second fasteners;

wherein each said rod retention cup has an open top end and an open bottom end, and said bottom end of said cup having a generally circular hole forming a bottom opening, said bottom opening being sized large enough to allow a portion of said respective fastener to pass through while retaining another portion of said fastener in said cup, and said top end of said cup having a top opening and a generally cylindrical wall

defining said top opening, said wall having at least two slots diametrically opposed to each other and extending downwardly from the uppermost portion of said wall, said generally cylindrical wall having an interior cylindrical wall surface with at least two inverted shoulders that each taper generally outwardly in an upward direction; and

installing a cap into each cup above said rod, each said cap being generally cylindrically shaped and having a pair of shoulders extending radially outwardly and in an upward direction, and said shoulders contact said inverted shoulders.

47. A method according to claim 46, further comprising

advancing a screw positioned in each cap through a screw hole in said cap in a manner in which said screw is tightened against said rod to apply pressure to said rod in order to lock said rod relative to said cup.

48. A method according to claim 46, further comprising

advancing a screw positioned in each cap through a screw hole in said cap in a manner in which said screw is tightened against said rod to apply pressure to said rod in order to lock said rod relative to said cup, and in order to draw said shoulders and said inverted shoulders into each other in a manner causing said generally cylindrical wall to be biased inwardly.

49. A support ring for use in a pedicle screw system, said ring comprising

a split-ring body adapted to be received in a cup-shaped spinal rod and pedicle screw retainer, said body being adapted to rest on top of a pedicle screw head and to support said rod thereon.

50. A ring according to claim 49, wherein

said body is resilient and is adapted to engage an inner circumferential surface of said retainer.

51. A ring according to claim 50, wherein

said body is adapted to be positioned in a groove on said inner circumferential surface.

52. A ring according to claim 49, wherein

said head and said ring are relatively sized such that said ring is fit around said head.

53. A ring according to claim 52, wherein

said ring is resiliently expanded when fit around said head.

54. A seat sleeve for use in a pedicle screw system, said sleeve comprising

a generally ring-shaped body having an inner surface and an outer surface, wherein said outer surface is adapted to engage the inner diameter of a cup-shaped spinal rod and pedicle screw retainer, and said inner surface is adapted to support a bone screw suspended therefrom.

55. A sleeve according to claim 54, wherein

said outer surface engages said inner diameter near a bottom opening of said retainer.

56. A sleeve according to claim 54, wherein

the outer diameter of said outer surface varies in a vertical direction.

57. A sleeve according to claim 54, wherein

the inner diameter of said inner surface varies in a vertical direction.

58. A sleeve according to claim 54, wherein

said outer surface is tapered.

59. A sleeve according to claim 54, wherein

said inner surface is tapered.

60. A sleeve according to claim 54, wherein

a vertical height dimension of said sleeve is greater than the difference between an outer diameter of said sleeve and an inner diameter of said sleeve.

61. A pedicle screw and rod retention system comprising

a cup-shaped first retention member having at least one slot for receiving a rod member therein, an open chamber for housing part of a fastener therein, a bottom opening from which part of said fastener extends, a top opening, and at least one inclined surface; and

a second retention member having at least one inclined surface that engages said inclined surface of said retention member.

62. A system according to claim 61, further comprising

a tensioning mechanism that selectively increases force between said inclined surfaces.

63. A system according to claim 61, further comprising

a tensioning mechanism that selectively increases force between said inclined surfaces and that biases a portion of said first retention member radially inwardly toward its central axis.

64. A system according to claim 61, further comprising

a rod engaging mechanism mounted in said second retention member that engages said rod.

65. A system according to claim 61, further comprising

a rod engaging mechanism mounted in said second retention member that engages said rod and that selectively increases force between said inclined surfaces.

66. A system according to claim 61, further comprising

a rod engaging mechanism mounted in said second retention member that engages said rod, that selectively increases force between said inclined surfaces, and that biases a portion of said first retention member radially inwardly toward its central axis.

67. A system according to claim 61, further comprising

a rod engaging mechanism mounted in said second retention member that engages said rod, that selectively increases force applied to the rod, that selectively increases force between said inclined surfaces, and that biases a portion of said first retention member radially inwardly toward its central axis.